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TRANSPORT LOCOMOTIVE AND WASTE PACKAGE TRANSPORTER ITS STANDARDS IDENTIFICATION STUDY

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TRANSPORT LOCOMOTIVE AND WASTE PACKAGE TRANSPORTER ITS STANDARDS IDENTIFICATION

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ACRONYMS

AAR	American Association of Railroads
BDBGM	beyond design base ground motion
BSC	Bechtel SAIC Company, LLC
BPCS	bedplate control system
DBGM	design base ground motion
DOE	Department of Energy
ECP	electronically controlled pneumatic
FCS	facility control system
HLRM	high level radioactive material
ITS	important to safety
LCS	locomotive control system
LBCS	locomotive brake control system
MCS	main control system
MT	metric ton
NITS	non-important to safety
NSDB	Nuclear Safety Design Basis
PCS	position control system
SCS	speed control system
SSC	structures, systems and components
SDCS	shield door control system
TCS	transporter control system
TBCS	transporter brake control system
WP	waste package

1. PURPOSE AND SCOPE

To date, the project has established important to safety (ITS) performance requirements for structures, systems and components (SSCs) based on identification and categorization of event sequences that may result in a radiological release. These performance requirements are defined within the *Nuclear Safety Design Basis for License Application (NSDB)* (BSC 2005). Further, SSCs credited with performing safe functions are classified as ITS. In turn, performance confirmation for these SSCs is sought through the use of consensus code and standards.

The purpose of this study is to identify applicable codes and standards for the waste package (WP) transporter and transport locomotive ITS SSCs. Further, this study will form the basis for selection and the extent of applicability of each code and standard.

This study is based on the design development completed for License Application only. Accordingly, identification of ITS SSCs beyond those defined within the NSDB are based on designs that may be subject to further development during detail design. Furthermore, several design alternatives may still be under consideration to satisfy certain safety functions, and that final selection will not be determined until further design development has occurred. Therefore, for completeness, throughout this study alternative designs currently under consideration will be discussed. Further, the results of this study will be subject to evaluation as part of a follow-on gap analysis study.

Based on the results of this study the gap analysis will evaluate each code and standard to ensure each ITS performance requirement is fully satisfied. When a performance requirement is not fully satisfied a “gap” is highlighted. Thereafter, the study will identify supplemental requirements to augment the code or standard to meet performance requirements. Further, the gap analysis will identify non-standard areas of the design that will be subject to a Development Plan. Non-standard components and non-standard design configurations are defined as areas of the design that do not follow standard industry practices or codes and standards. Whereby, performance confirmation can not be readily sought through use of consensus standards.

In order for this to be accomplished, a control schematic will be developed to correlate with the baseline configuration presented in the *Waste Package Transporter Preclosure Safety Analysis* (BSC 2004).

The study contained in this document has been developed by Design & Engineering / Mechanical Handling in its work regarding ITS codes and standards identification for the Emplacement and Retrieval. Yucca Mountain Project personnel from Design & Engineering / Mechanical Handling should be consulted before use of the study for purposes other than those stated herein or used by individuals other than authorized personnel in Design & Engineering / Mechanical Handling.

2. QUALITY ASSURANCE

This document was prepared in accordance with LP-ENG-014-BSC, *Engineering Studies*. The results of this document are only to be used as the basis for selection of applicable codes and

standards and are not to be used directly to generate quality products. Therefore, this engineering study is not subject to requirements of the *Quality Assurance Requirements and Description* document (DOE 2004).

3. USE OF COMPUTER SOFTWARE

Computer software used, Microsoft Word 1997, in this study is classified as exempt from procedure LP-SI.11Q-BSC, *Software Management*. All software used to prepare this analysis is listed under Section 2.1 Software Not Subject To This Procedure, of LP-SI.11Q-BSC, *Software Management*.

4. TRANSPORT LOCOMOTIVE AND WP TRANSPORTER FUNCTIONAL DESCRIPTION

Before these ITS Codes and standards can be identified, a basic control block diagram needs to be developed to correlate with the baseline configuration presented in the *Waste Package Transporter Preclosure Safety Analysis*. Within the *Waste Package Transporter Preclosure Safety Analysis*, a fault tree analysis was performed with two possible alternatives that meet the necessary reliability. Alternative 1 is a single-channel dynamic brake in conjunction with the basic service brake system (BSC 2004, Section 6.8.2). Alternative 2 is a single-channel independent brake in conjunction with the basic service brake system (BSC 2004, Section 6.8.3).

4.1 LOCOMOTIVE

The primary function of the transport locomotive is to move the WP transporter and other rail-based support equipment utilized by the emplacement and retrieval system, such as the gantry carrier and WP transporter.

4.1.1 Transport Locomotive Basic Control System

Figure 4.1.1-1 depicts a generalized control block diagram of LCS interface with the following systems and components:

- main control system (MCS)
- locomotive control system (LCS)
- speed control system (SCS)
- transporter control system (TCS)
- locomotive brake control system (LBCS)
- coupler (connects to the WP transporter)
- drive system
- speed sensor
- dynamic brake
- pneumatic tread brake system
- disc brake system

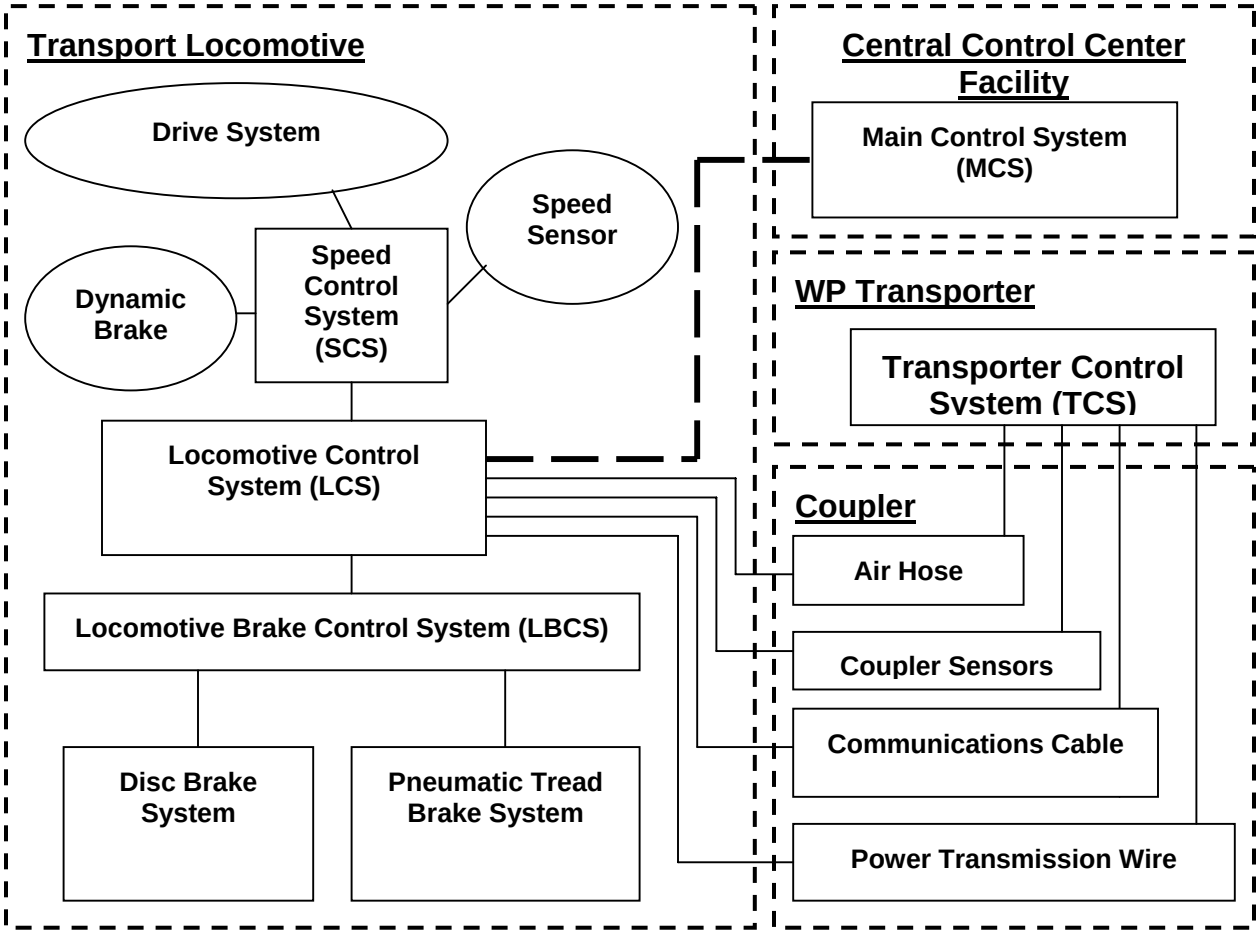

Figure 4.1.1-1: Transport Locomotive Basic Control Block Diagram

4.2 WP TRANSPORTER

The primary function of the WP transporter is to safely transport waste packages between the Surface Facilities and the emplacement transfer docks for both emplacement and retrieval operations. The transport locomotive provides the motive force for all movements of the waste package transporter. The transporter primarily consists of a radiological shielded enclosure (with bedplate) mounted to a railcar.

4.2.1 WP Transporter Basic Control System

Figure 4.2.1-1 depicts a generalized control block diagram of the TCS interface with the following systems and components:

- facility control system (FCS)
- transporter control system (TCS)
- locomotive control system (LCS)
- position control system (PCS)
- bedplate control system (BPCS)
- shield door control system (SDCS)
- transporter brake control system (TBCS)
- coupler (connects to the transport locomotive)
- Position Detector
- radiation detection sensor
- pneumatic tread brake system
- disc brake system
- bedplate position sensor
- bedplate drive system
- bedplate locking mechanism
- shield door position sensor
- shield door locking mechanism
- shield door drive mechanism

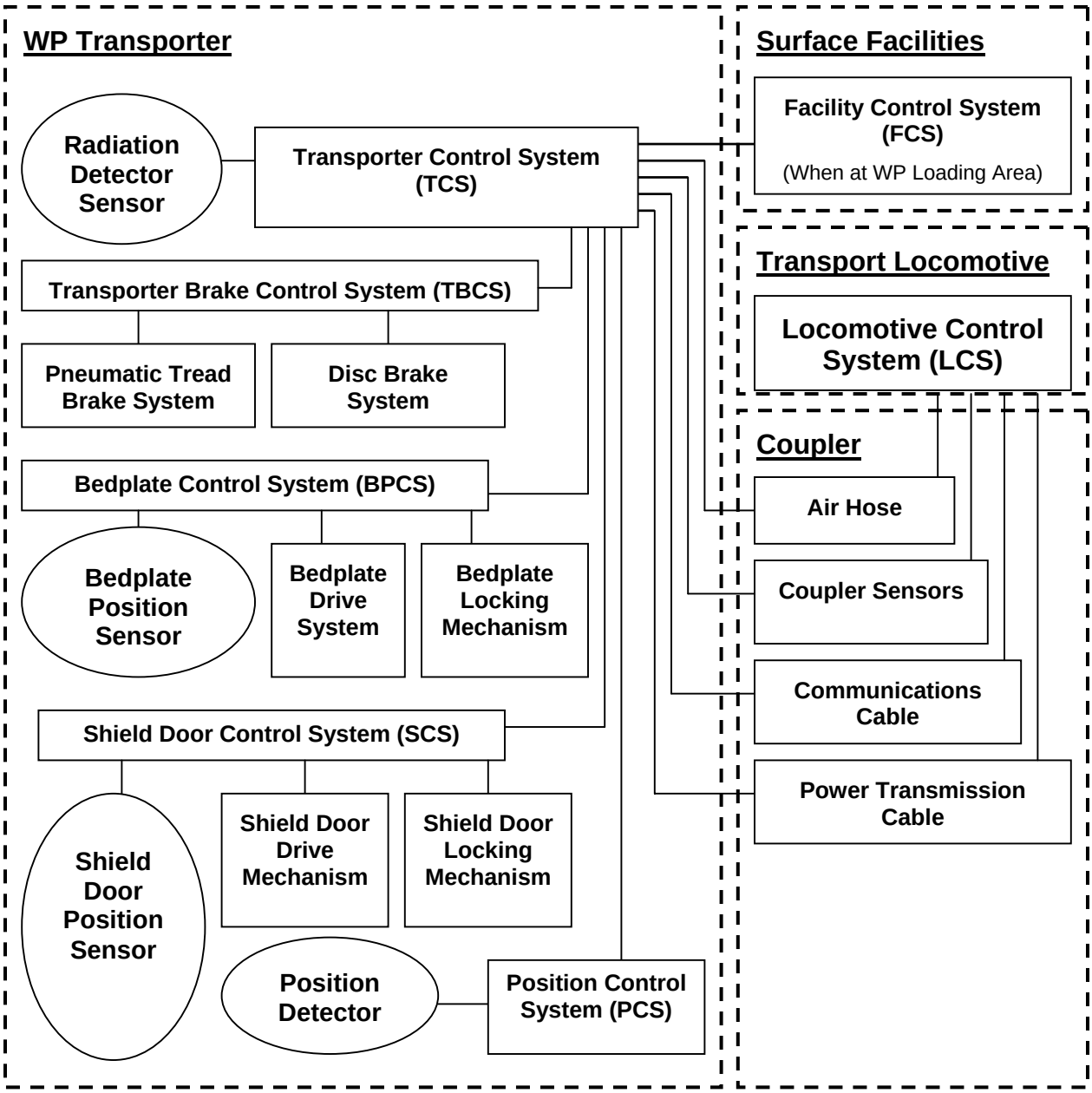

Figure 4.2.1-1: WP Transporter Basic Control Block Diagram

4.3 ALTERNATIVE 1

Alternative 1 is a single-channel dynamic brake in conjunction with the basic service brake system (BSC 2004, Section 6.8.2).

4.3.1 Transport Locomotive Basic Control System

Figure 4.3.1-1 represents the transport locomotive basic control system (for alternative 1) with the systems and components identified as ITS or NITS.

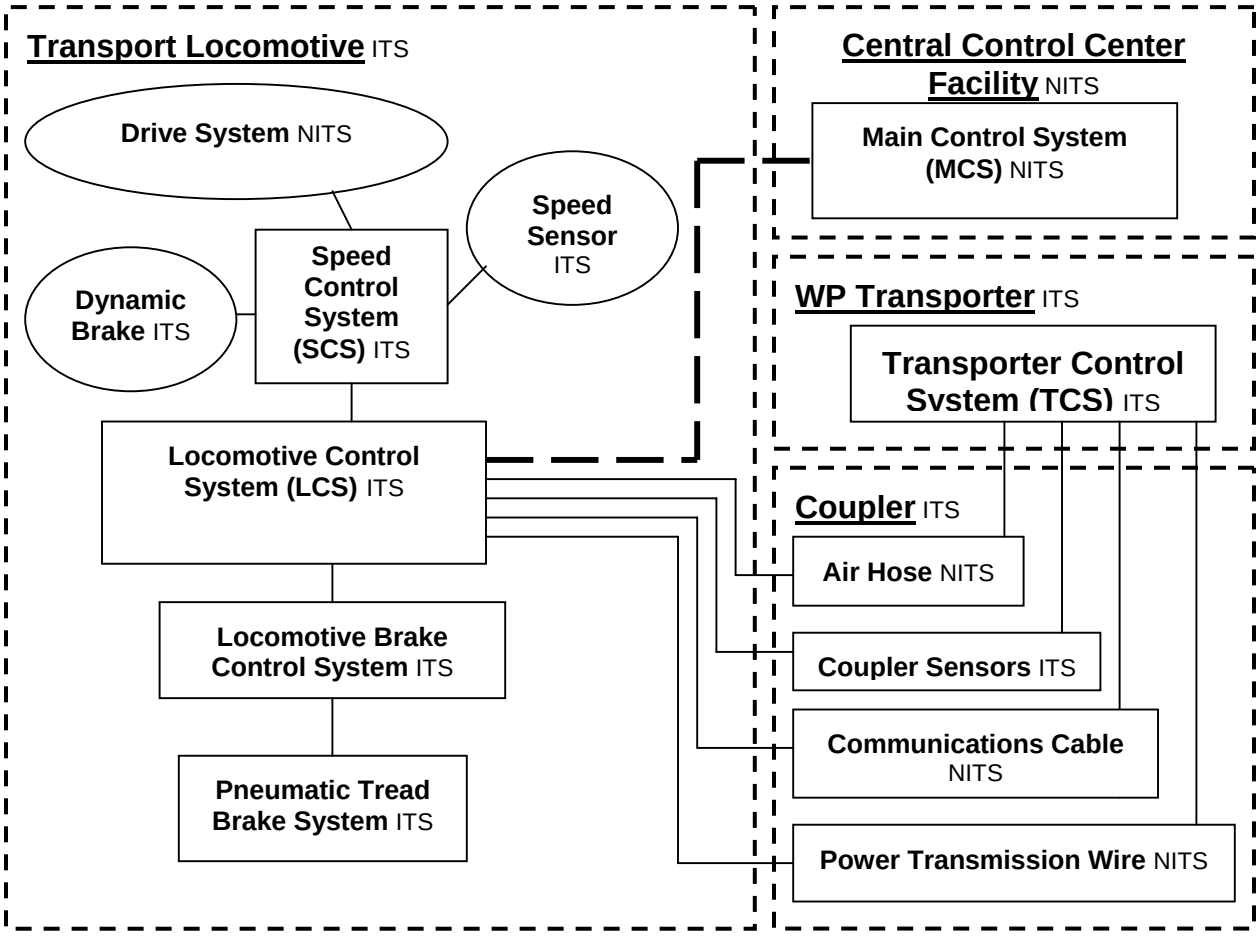

Figure 4.3.1-1: Alternative 1 Transport Locomotive Basic Control Block Diagram

4.3.2 WP Transporter Basic Control System

Figure 4.3.2-1 represents the WP transporter basic control system (for alternative 1) with the systems and components identified as ITS or NITS.

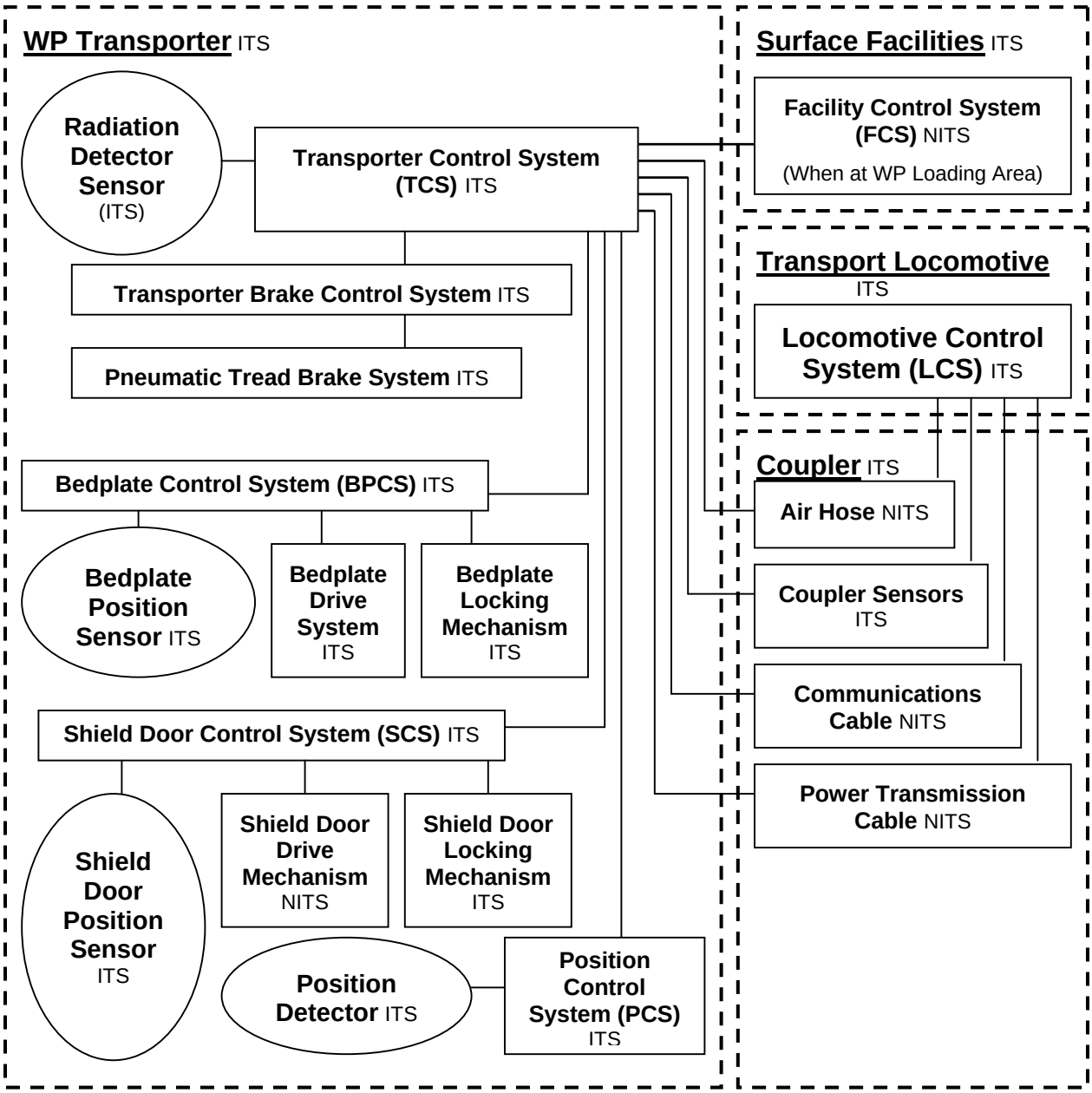

Figure 4.3.2-1: Alternative 1 WP Transporter Basic Control Block Diagram

4.4 ALTERNATIVE 2

Alternative 2 is a single-channel independent brake in conjunction with the basic service brake system (BSC 2004, Section 6.8.3).

4.4.1 Transport Locomotive Basic Control System

Figure 4.4.1-1 represents the transport locomotive basic control system (for alternative 2) with the systems and components identified as ITS or NITS.

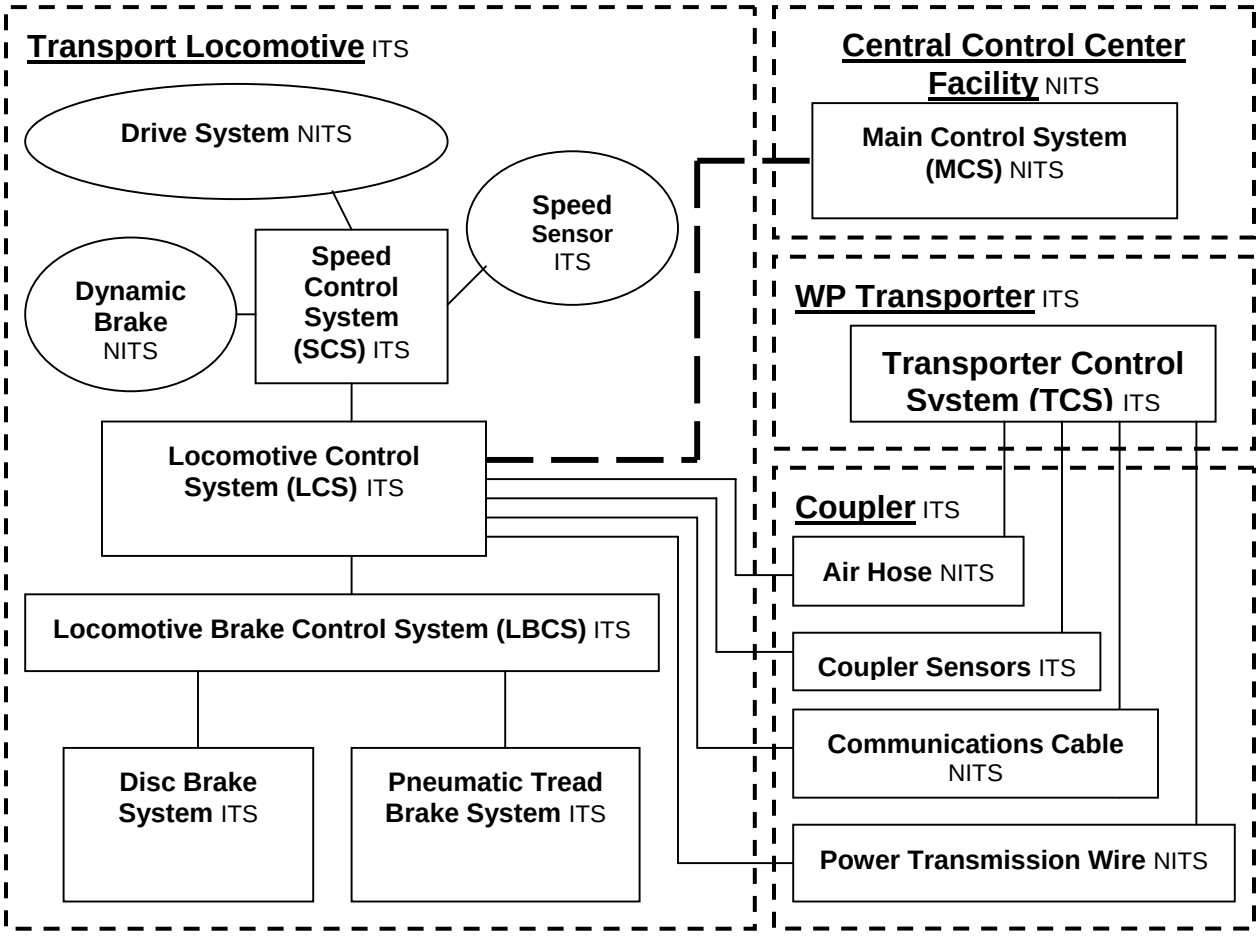

Figure 4.4.1-1: Alternative 2 Transport Locomotive Basic Control Block Diagram

4.4.2 WP Transporter Basic Control System

Figure 4.4.2-1 represents the WP transporter basic control system (for alternative 2) with the systems and components identified as ITS or NITS.

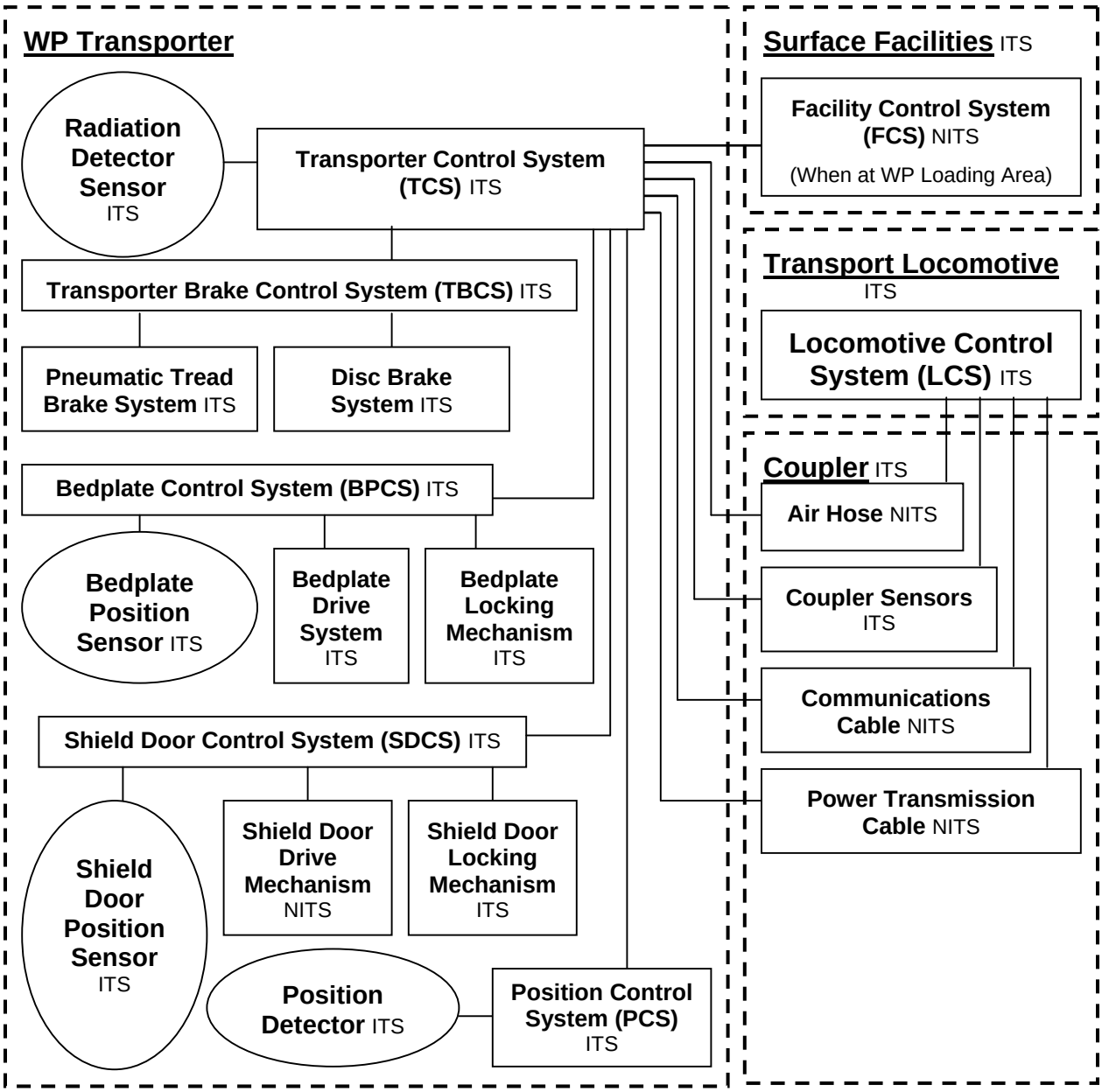

Figure 4.4.2-1: Alternative 2 WP Transporter Basic Control Block Diagram

5. ITS REQUIREMENTS FOUND

The ITS requirements that were identified in this study were directly taken out of the *Nuclear Safety Design Basis for License Application* (BSC 2005). There were no additional ITS requirements identified other than the thirteen ITS requirements listed in the *Nuclear Safety Design Basis for License Application* (BSC 2005). See Section 8 for a listing of other documents reviewed.

5.1 REQUIREMENTS

Each requirement that was identified in the NSDB has been assigned its own requirement number, and is highlighted in an italic font, in this document.

5.1.1 Requirement 1

"*The WP Transporter shall transport the WP in a manner such that if a collision or derailment (excluding tipover) occurs, the WP impact energy will be low enough to preclude a WP breach; this impact energy translates into a maximum WP Transporter speed of 15 mph*" (BSC 2005, Table A-II).

Since the transporter shall not exceed the speed of 15 mph, the following are ITS functions: speed detection, speed limiting/braking, and the coupler connection and detection. The coupler connection and detection is ITS because the locomotive assists in the speed limiting/braking function and therefore must remain coupled to the WP Transporter. The SSC performing the speed detection function is a speed sensor. The SSCs performing the speed limiting/braking function are the dynamic braking (Alternative 1 only), the pneumatic tread brake system, and the disc brake system (Alternative 2 only). The SSC performing the ITS function for the coupler connection detection is the coupler sensor. With these SSCs, the interlocking controls also have to be ITS. The SCS receives information from the speed sensor and activates the dynamic braking if the maximum speed is exceeded. If the excessive speed is continued, the TCS and LCS then activates the brakes through the LBCS and TBCS. Table 5.1.1-1 and Table 5.1.1-2 contains the identified SSCs and ITS functions.

Table 5.1.1-1: Transport Locomotive Identified ITS Functions

SSC	ITS Function	Code and Standard Reference
Transport Locomotive Control System	Locomotive Interlocking Controls	Section 6.1.1
Speed Control System	Speed Control Interlocking Controls	Section 6.1.1.1
Speed Sensor	Speed Detection	Section 6.1.1.1
Dynamic Braking Control System (Alternative 1 Only)	Speed Limiting	Section 6.1.1.1
Transport Locomotive Brake Control System	Brake Interlocking Controls	Section 6.1.1.2
Pneumatic Tread Brake Systems	Braking	Section 6.1.1.2.1
Disc Brake Systems (Alternative 2 Only)	Braking	Section 6.1.1.2.2
Coupler & Coupler Sensor	Coupler Connection & Detection	Section 6.1.1.3

Table 5.1.1-2: WP Transporter Identified ITS Functions

SSC	ITS Function	Code and Standard Reference
WP Transporter Control System	Transporter Interlocking Controls	Section 6.2.1
WP Transporter Brake Control System	Brake Interlocking Controls	Section 6.2.1.1
Pneumatic Tread Brake System	Braking	Section 6.2.1.1.1
Disc Brake System (Alternative 2 Only)	Braking	Section 6.2.1.1.2
Coupler & Coupler Sensor	Coupler Connection & Detection	Section 6.2.1.2

5.1.2 Requirement 2

"*The WP Transporter shall transport the WP in a manner such that if a collision or derailment leading to a WP Transporter tipover occurs, the WP impact energy will be low enough to preclude a WP breach*" (BSC 2005, Table A-II).

The height at which the WP is transported is ITS to ensure that in the event of a tipover the WP impact energy with the grade will be low enough to preclude a WP breach. This will be addressed later during the gap analysis. Table 5.1.2-1 contains the identified SSC and ITS functions.

Table 5.1.2-1: WP Transporter Identified ITS Function

SSC	ITS Function	Code and Standard Reference
WP Transporter Design	Height at which the WP is transported	None

5.1.3 Requirement 3

"*While on the surface, the WP transporter shall be designed to function in extreme straight wind (90 mph)*" (BSC 2005, Table A-II).

In extreme straight wind, the SSCs must maintain their safety function. Therefore, the design must contain barriers to protect the SSCs and will be addressed later in the gap analysis. Table 5.1.3-1 contains the identified SSC and ITS functions.

Table 5.1.3-1: WP Transporter Identified ITS Function

SSC	ITS Function	Code and Standard Reference
External Body Surface	Protection of SSC equipment	None
Suspension Design	Maintain Safety function during high wind	Section 6.2.3

5.1.4 Requirement 4

"*The WP Transporter and its bedplate shall not collide with a WP on the WP turntable and cause a WP breach*" (BSC 2005, Table A-II).

To prevent a collision with the WP on the WP turntable, the following are ITS functions: transporter / bedplate limit switches, and the braking. The SSC performing the transporter limit switch function is a position sensor. The SSC performing the bedplate limit switch function is a bedplate position sensor. The SSCs performing the braking function are the pneumatic tread brake subsystem, and the disc brake subsystem (Alternative 2 only). With these SSCs, the interlocking controls also have to be ITS. Table 5.1.4-1 and Table 5.1.4-2 contains the identified SSCs and ITS functions.

Table 5.1.4-1: Transport Locomotive Identified ITS Functions

SSC	ITS Function	Code and Standard Reference
Transport Locomotive Control System	Locomotive Interlocking Controls	Section 6.1.1
Transport Locomotive Brake Control System	Brake Interlocking Controls	Section 6.1.1.2
Pneumatic Tread Brake Systems	Braking	Section 6.1.1.2.1
Disc Brake Systems (Alternative 2 Only)	Braking	Section 6.1.1.2.2

Table 5.1.4-2: WP Transporter Identified ITS Functions

SSC	ITS Function	Code and Standard Reference
WP Transporter Control System	Interlock Controls	Section 6.2.1
Position Control System	Interlock Controls	Section 6.2.1.5
Positon Sensor	Position Locator	Section 6.2.1.5.1
WP Transporter Brake Control System	Interlock Controls	Section 6.2.1.1
Pneumatic Tread Brake System	Braking	Section 6.2.1.1.1
Disc Brake System (Alternative 2 Only)	Braking	Section 6.2.1.1.2
Bedplate Control System	Interlock Controls	Section 6.2.1.3
Bedplate Position Sensor	Limit Switch	Section 6.2.1.3.2

5.1.5 Requirement 5

"*The rate of a WP Transporter runaway shall be less than* 8.3×10^{-9} *runaways per trip*" (BSC 2005, Table A-II).

To prevent WP transporter runaway, the following are ITS functions: speed detection, speed limiting/braking, and the coupler connection and detection. The SSC performing the speed detection function is a speed sensor. The SSCs performing the speed limiting/braking functions are the dynamic braking (Alternative 1 only), the pneumatic tread brake system, and the disc brake system (Alternative 2 only). The coupler sensors are the SSCs that sense the coupler connection. With these SSCs, the interlocking controls also have to be ITS. The SCS receives information from the speed sensor and activates the dynamic braking if the maximum speed is exceeded. If the excessive speed is continued, the TCS and LCS then activates the brakes through the LBCS and TBCS. Table 5.1.5-1 and Table 5.1.5-2 contains the Identified SSCs and functions.

Table 5.1.5-1: Transport Locomotive Identified ITS Functions

SSC	ITS Function	Code and Standard Reference
Transport Locomotive Control System	Locomotive Interlocking Controls	Section 6.1.1
Speed Control System	Speed Control Interlocking Controls	Section 6.1.1.1
Speed Sensor	Speed Detection	Section 6.1.1.1
Dynamic Braking Control System (Alternative 1 Only)	Speed Limiting	Section 6.1.1.1
Transport Locomotive Brake Control System	Brake Interlocking Controls	Section 6.1.1.2
Pneumatic Tread Brake Systems	Braking	Section 6.1.1.2.1
Disc Brake Systems (Alternative 2 Only)	Braking	Section 6.1.1.2.2
Coupler & Coupler Sensor	Coupler Connection & Detection	Section 6.1.1.3

Table 5.1.5-2: WP Transporter Identified ITS Functions

SSC	ITS Function	Code and Standard Reference
WP Transporter Control System	Transporter Interlocking Controls	Section 6.2.1
WP Transporter Brake Control System	Brake Interlocking Controls	Section 6.2.1.1
Pneumatic Tread Brake System	Braking	Section 6.2.1.1.1
Disc Brake System (Alternative 2 Only)	Braking	Section 6.2.1.1.2
Coupler & Coupler Sensor	Coupler Connection & Detection	Section 6.2.1.2

5.1.6 Requirement 6

"*The WP Transporter (together with the locomotive and coupler) shall be designed to prevent runaway of the WP Transporter for loading conditions associated with a DBGM-2 seismic event. In addition, an analysis shall demonstrate that the WP Transporter (together with the locomotive and coupler) has sufficient seismic design margin to ensure that a "no runaway" safety function is maintained for loading conditions associated with a BDBGM seismic event*" (BSC 2005, Table A-II).

To prevent WP transporter runaway from the DBGM-2 seismic event, the following are ITS functions: speed detection, speed limiting/braking, and the coupler connection detection. The speed detection ITS function is performed by the speed sensors. The speed limiting/braking ITS function is performed by the SCS, the dynamic braking (Alternative 1), the pneumatic tread braking, and the disc braking (Alternative 2). The coupler sensors are the SSCs that sense the coupler connection. With these SSCs, the interlocking controls also have to be ITS. The SCS receives information from the speed sensor and activates the dynamic braking if the maximum speed is exceeded. If the excessive speed is continued, the TCS and LCS then activates the braking through the LBCS and TBCS. Table 5.1.6-1 and Table 5.1.6-2 contains the Identified SSCs and functions.

Table 5.1.6-1: Transport Locomotive Identified ITS Functions

SSC	ITS Function	Code and Standard Reference
Transport Locomotive Control System	Locomotive Interlocking Controls	Section 6.1.1
Speed Control System	Speed Control Interlocking Controls	Section 6.1.1.1
Speed Sensor	Speed Detection	Section 6.1.1.1
Dynamic Braking Control System (Alternative 1 Only)	Speed Limiting	Section 6.1.1.1
Transport Locomotive Brake Control System	Brake Interlocking Controls	Section 6.1.1.2
Pneumatic Tread Brake Systems	Braking	Section 6.1.1.2.1
Disc Brake Systems (Alternative 2 Only)	Braking	Section 6.1.1.2.2
Coupler & Coupler Sensor	Coupler Connection & Detection	Section 6.1.1.3

Table 5.1.6-2: WP Transporter Identified ITS Functions

SSC	ITS Function	Code and Standard Reference
WP Transporter Control System	Transporter Interlocking Controls	Section 6.2.1
WP Transporter Brake Control System	Brake Interlocking Controls	Section 6.2.1.1
Pneumatic Tread Brake System	Braking	Section 6.2.1.1.1
Disc Brake System (Alternative 2 Only)	Braking	Section 6.2.1.1.2
Coupler & Coupler Sensor	Coupler Connection & Detection	Section 6.2.1.2

5.1.7 Requirement 7

"*The WP Transporter shall be designed for loading conditions associated with a DBGM-1 level seismic event and demonstrate sufficient margin to a "shielding integrity remains intact" safety function*" (BSC 2005, Table A-II).

With a DBGM-1 level seismic event, the shielding integrity must remain intact. The WP transporter shielded compartment, shield doors, shield door hinges, and shield door locking mechanism must be designed and constructed to provide the required shielding after a DBGM-1 level seismic event. Table 5.1.7-1 contains the Identified SSCs and ITS function.

Table 5.1.7-1: WP Transporter Identified ITS Function

SSC	ITS Function	Code and Standard Reference
Shielded Compartment	Shielding Integrity	Section 6.2.2
Shielded Compartment Doors	Shielding Integrity	Section 6.2.2
Shield Door Locking Mechanism	Shield Doors Restraint	Section 6.2.1.4.1
Shielded Compartment Door Hinges	Shield Doors Restraint	Section 6.2.1.4.2

5.1.8 Requirement 8

"*The transporter shielded compartment shall withstand any fall of failed ground support materials, as well as a set of rockfalls having a total mass of 5.4 MT, without jeopardizing the structural integrity of the WP*" (BSC 2005, Table A-II).

After a rockfall/failed ground support event, the structural integrity must remain intact. The WP transporter shielded compartment and shield doors must be designed and constructed to provide the required structural protection for the WP after a rockfall/failed ground support event (with a total mass of 5.4 MT). Table 5.1.8-1 contains the Identified SSCs and ITS function.

Table 5.1.8-1: WP Transporter Identified ITS Function

SSC	ITS Function	Code and Standard Reference
Shielded Compartment	Structural Integrity	Section 6.2.2
Shielded Compartment Doors	Structural Integrity	Section 6.2.2

5.1.9 Requirement 9

"*Movement of the WP transporter shielded enclosure doors shall not breach the WP or cause it to fall from the bedplate of the transporter*" (BSC 2005, Table A-II).

During the loading or unloading, protection for the WP colliding with the shield doors is needed. The ITS functions must prevent the shield doors from closing until the bedplate is fully retracted and preventing bedplate extention while the shield doors are closed. Therefore, the ITS functions are detecting bedplate position and shield doors positions. With these identified SSCs the interlocking controls also have ITS functions. The BPCS receives data from the Bedplate Position Sensor. The SDCS receives data from the Shield Door Position Sensor. The TCS interlocks the BPCS with SDCS. Table 5.1.9-1 contains the Identified SSCs and ITS functions.

Table 5.1.9-1: WP Transporter Identified ITS Function

SSC	ITS Function	Code and Standard Reference
WP Transporter Control System	Transporter Interlocking Controls	Section 6.2.1
Bedplate Control System	Bedplate Interlocking Controls	Section 6.2.1.3
Bedplate Position Sensor	Detecting Bedplate Position	Section 6.2.1.3.2
Shield Door Control System	Shield Doors Interlocking Controls	Section 6.2.1.4
Shield Door Position Sensors	Detecting Shield Door Position	Section 6.2.1.4.3

5.1.10 Requirement 10

"*The restraints used to immobilize the bedplate inside the shielded compartment of the WP Transporter and the mechanism for locking the doors of the shielded compartment shall withstand a collision or derailment (including tipover) of the transporter without resulting in a Category 1 or Category 2 event sequence*" (BSC 2005, Table A-II).

During transport of the WP, restraints are required to immobilize the bedplate. Also, prevention of the shielded doors opening during a collision or derailment (including tipover). The ITS functions are restraining the shield door, bedplate and WP, which are accomplished with the shield door locking mechanism, shield door hinges, bedplate locking mechanisms, shielded compartment doors and shielded compartment. With these identified SSCs the interlocking controls also have ITS functions. The TCS sends information to the BPCS and SDCS for activating the Bedplate / Shield Door Locking Mechanisms. In turn, the BPCS and SDCS activate the Bedplate / Shield Door Locking Mechanisms. Table 5.1.10-1 contains the Identified SSCs and ITS functions.

Table 5.1.10-1: WP Transporter Identified ITS Function

SSC	ITS Function	Code and Standard Reference
WP Transporter Control System	Transporter Interlocking Controls	Section 6.2.1
Bedplate Control System	Bedplate Interlocking Controls	Section 6.2.1.3
Bedplate Locking Mechanism	Bedplate Restraint	Section 6.2.1.3.1
Shield Door Control System	Shield Doors Interlocking Controls	Section 6.2.1.4
Shield Door Locking Mechanism	Shield Doors Restraint	Section 6.2.1.4.1
Shield Door Hinges	Shield Doors Restraint	Section 6.2.1.4.2
Shielded Compartment	Shielding and WP Restraint	Section 6.2.2
Shielded Compartment Doors	Shielding and WP Restraint	Section 6.2.2

5.1.11 Requirement 11

"*Spurious or operator-induced opening of the WP shielded compartment followed by a bedplate roll-out shall be precluded when the transporter is in motion*" (BSC 2005, Table A-II).

During transport of the WP, operator-induced opening of the WP shielded compartment and bedplate extraction should be precluded. The ITS function is restricting areas, by position sensors, detecting where the shield doors can open. With these identified SSCs the interlocking controls also have ITS functions. The TCS receives information from the PCS and permits the opening of the shield doors. The PCS receives information from the position sensor and determines the location of the WP Transporter. Table 5.1.11-1 contains the Identified SSCs and ITS functions.

Table 5.1.11-1: WP Transporter Identified ITS Function

SSC	ITS Function	Code and Standard Reference
WP Transporter Control System	Transporter Interlocking Controls	Section 6.2.1
Position Control System	Position Interlocking Controls	Section 6.2.1.5
Position Sensor	Position Locator	Section 6.2.1.5.1

5.1.12 Requirement 12

"*Radiation exposure to workers due to inadvertent actuation of the WP transporter shielded compartment doors shall be precluded such that this is not a Category 1 event*" (BSC 2005, Table A-II).

Inadvertent actuation of the WP shielded doors should be precluded such that it is not a Category 1 event. Therefore, the ITS function is restricting areas where the shield doors can open when a radioactive source is present. Also, preventing the shield doors opening in maintenance areas with a radiation source within the shielded compartment. Therefore, the ITS functions are the position locator and radiation source detection. The position sensor performs the position locator function; and the radiation detector performs the radiation source detection function. With these SSCs, the interlocking controls also have ITS functions. The TCS receives information from the PCS and the radiation detector and permits the opening of the shield doors. The PCS receives information from the position sensor and determines the location of the WP Transporter. Table 5.1.12-1 contains the Identified SSCs and ITS functions.

Table 5.1.12-1: WP Transporter Identified ITS Function

SSC	ITS Function	Code and Standard Reference
WP Transporter Control System	Transporter Interlocking Controls	Section 6.2.1
Position Control System	Position Interlocking Controls	Section 6.2.1.5
Position Sensor	Position Locator	Section 6.2.1.5.1
Radiation Detector	Radiation Source Detection	Section 6.2.1.6

5.1.13 Requirement 13

"*Upon a loss of power, the WP Transporter shall be designed to stop, retain the load, and enter a locked mode; upon a restoration of power, the WP Transporter shall stay in the locked mode until operator action is taken*" (BSC 2005, Table A-II).

Upon loss of power, the ITS function is braking. The SSCs performing the braking function are the pneumatic tread brake system and the disc brake system (Alternative 2 only). The Transport Locomotive and WP Transporter automatically enter fail safe condition. For example, during power loss the brakes automatically engage. Upon power restoration, operator action must be performed to reset and restart the Transport Locomotive and WP Transporter motion. Table 5.1.13-1 and Table 5.1.13-2 contains the Identified SSCs and ITS functions.

Table 5.1.13-1: Transport Locomotive Identified ITS Functions

SSC	ITS Function	Code and Standard Reference
Pneumatic Tread Brake Systems	Braking	Section 6.1.1.2.1
Disc Brake Systems (Alternative 2 Only)	Braking	Section 6.1.1.2.2

Table 5.1.13-2: WP Transporter Identified ITS Functions

SSC	ITS Function	Code and Standard Reference
Pneumatic Tread Brake System	Braking	Section 6.2.1.1.1
Disc Brake System (Alternative 2 Only)	Braking	Section 6.2.1.1.2

6. IDENTIFIED ITS CODES AND STANDARDS

In order to capture all of the codes and standards an exhaustive study was performed. This study consisted of an evaluation of industry consensus codes and standards to identify applicability to the ITS SSCs. Refer to Section 8.5 for a list of codes, standards, regulations, and directives reviewed for this section. The codes and standards selected were based upon their applicability to the requirements of the ITS SSCs, in particular within a nuclear environment. The evaluation of the identified industry codes and standards (see section 7.2 for a list of identified Industry Codes and Standards) looked at the applicable sections of each code and standard. This was done to ensure that the design, construction, installation, testing, and operations were all analyzed to show how each of the particular SSC will satisfy the ITS requirements.

Note: The extent of the applicability of each code and standard identified will be further defined through the completion of a subsequent gap analysis study.

6.1 TRANSPORT LOCOMOTIVE

6.1.1 Transport Locomotive Control System

The codes and standards listed in Table 6.1.1-1 will be used in their entirety. The locomotive control system (LCS) provides the operator local control console, and radio frequency (RF) communications to the operators in the main control system (MCS) (see Figure 4.3.1-1 and Figure 4.3.2-1). The LCS interfaces to the SCS, LBCS, power transmission, and communication with the transporter though an umbilical communications cable attached to the transporter. The LCS will contain the functional and design requirements established in IEEE Std 603-1998, and IEEE Std 7-4.3.2-2003 for the instrumentation and control portions of the LCS. The additional IEEE and ANSI/ISA Standards will provide the installation/mounting, independence, setpoints, single failure criteria, and qualification requirements for the system.

Table 6.1.1-1 is a list of applicable codes and standards for the Locomotive Control System.

Table 6.1.1-1: Transport Locomotive Control System Applicable Codes and Standards

Applicable Code or Standard	Sections	Title
ANSI/IEEE Std 344-1987*	Entire	*IEEE Recommended Practice for Seismic Qualification of Class 1E Equipment for Nuclear Power Generating Stations*
ANSI/ISA-67.01.01-2002*	Entire	*Transducer and Transmitter Installation for Nuclear Safety Applications*
ANSI/ISA-67.04.01-2000*	Entire	*Setpoints for Nuclear Safety Related Instrumentation-Formally ANSI/ISA-S67.04-2000*
IEEE Std 7-4.3.2-2003*	Entire	*IEEE Standard Criteria for Digital Computers in Safety Systems of Nuclear Power Generating Stations*
IEEE Std 323-2003*	Entire	*IEEE Standard for Qualifying Class 1E Equipment for Nuclear Power Generating Stations*
IEEE Std 379-2000*	Entire	*IEEE Standard Application of the Single-Failure Criterion to Nuclear Power Generating Station Safety Systems*
IEEE Std 384-1992*	Entire	*Standard Criteria for Independence of Class 1E Equipment and Circuits*
IEEE Std 603-1998*	Entire	*Standard Criteria for Safety Systems in Nuclear Power Generating Stations*

* These nuclear standards apply for nuclear power industry and may not necessarily apply to rail SSCs.

6.1.1.1 Transport Locomotive Speed Control System

This section is applicable in Alternative 1 only. Even though standard AAR 2004, Section M Standard S-5018 is specific to diesel-electric locomotives, some of the principles presented may be applicable to an electric locomotive. It is however, the only established railroad standard for dynamic braking. Further analysis needs to be performed and dynamic braking will be addressed later within the gap analysis.

The codes and standards listed in Table 6.1.1-2 will be used in their entirety. The locomotive speed control system (SCS) provides the instrumentation and speed control capability to the local operators and to the operators in the main control system (MCS) via the LCS (see Figure 4.3.1-1 and Figure 4.4.1-1). The SCS interfaces with the LCS, dynamic brake, drive system, and the speed sensor. The SCS will contain the functional and design requirements established in IEEE 603-1998 and IEEE 7-4.3.2-2003 for the instrumentation and control portions of the SCS. The additional IEEE and ANSI/ISA Standards will provide the installation/mounting, independence, setpoints, single failure criteria, and qualification requirements for the system.

For this requirement, the speed sensor and the dynamic brake subsystem are ITS. The SCS applicable codes and standards are shown in Table 6.1.1-2.

Table 6.1.1-2: Transport Locomotive Speed Control System Applicable Codes and Standards

Applicable Code or Standard	Sections	Title
AAR 2004, Section M, S-5018	Entire	*Dynamic Braking Control (May not be Applicable)*
ANSI/IEEE Std 344-1987*	Entire	*IEEE Recommended Practice for Seismic Qualification of Class 1E Equipment for Nuclear Power Generating Stations*
ANSI/ISA-67.01.01-2002*	Entire	*Transducer and Transmitter Installation for Nuclear Safety Applications*
ANSI/ISA-67.04.01-2000*	Entire	*Setpoints for Nuclear Safety Related Instrumentation-Formally ANSI/ISA-S67.04-2000*
IEEE Std 7-4.3.2-2003*	Entire	*IEEE Standard Criteria for Digital Computers in Safety Systems of Nuclear Power Generating Stations*
IEEE Std 323-2003*	Entire	*IEEE Standard for Qualifying Class 1E Equipment for Nuclear Power Generating Stations*
IEEE Std 379-2000*	Entire	*IEEE Standard Application of the Single-Failure Criterion to Nuclear Power Generating Station Safety Systems*
IEEE Std 384-1992*	Entire	*Standard Criteria for Independence of Class 1E Equipment and Circuits*
IEEE Std 603-1998*	Entire	*Standard Criteria for Safety Systems in Nuclear Power Generating Stations*

* These nuclear standards apply for nuclear power industry and may not necessarily apply to rail SSCs.

6.1.1.2 Transport Locomotive Brake Control System

The LBCS interfaces the pneumatic tread brake subsystem and the disc brake system (Alternative 2 Only) (See Figure 4.3.1-1 and Figure 4.4.1-1).

Braking commands issued from the LCS are interrogated by the LBCS and the appropriate braking response is sent to the brakes. Braking can be applied independently to the locomotive, the transporter, or both the locomotive and the transporter.

The LBCS will contain the functional and design requirements established in IEEE Std 603-1998, and IEEE 7-4.3.2-2003 for the instrumentation and control portions of the LBCS. The additional IEEE and ANSI/ISA Standards will provide the installation/mounting, independence, Setpoints, single failure criteria, and qualification requirements for the system.

Table 6.1.1-3 lists the applicable codes and standards for the locomotive brake control systems.

Table 6.1.1-3: Transport Locomotive Brake Control System Applicable Codes and Standards

Applicable Code or Standard	Sections	Title
ANSI/IEEE Std 344-1987*	Entire	*IEEE Recommended Practice for Seismic Qualification of Class 1E Equipment for Nuclear Power Generating Stations*
ANSI/ISA-67.01.01-2002*	Entire	*Transducer and Transmitter Installation for Nuclear Safety Applications*
ANSI/ISA-67.04.01-2000*	Entire	*Setpoints for Nuclear Safety Related Instrumentation-Formally ANSI/ISA-S67.04-2000*
IEEE Std 7-4.3.2-2003*	Entire	*IEEE Standard Criteria for Digital Computers in Safety Systems of Nuclear Power Generating Stations*
IEEE Std 323-2003*	Entire	*IEEE Standard for Qualifying Class 1E Equipment for Nuclear Power Generating Stations*
IEEE Std 379-2000*	Entire	*IEEE Standard Application of the Single-Failure Criterion to Nuclear Power Generating Station Safety Systems*
IEEE Std 384-1992*	Entire	*Standard Criteria for Independence of Class 1E Equipment and Circuits*
IEEE Std 603-1998*	Entire	*Standard Criteria for Safety Systems in Nuclear Power Generating Stations*

* These nuclear standards apply for nuclear power industry and may not necessarily apply to rail SSCs.

6.1.1.2.1 Pneumatic Tread Brake Subsystem

Contained in Table 6.1.1-4, are the railroad industry brake standards for locomotives. With the current design, numerous AAR 2004, Section M standards apply. These standards discuss the braking system design and components for locomotives. As the design progresses and equipment selection is made, many of the standards will no longer apply.

The pneumatic tread brake subsystem gets braking commands from the TBCS (see Figure 4.3.2-1 and Figure 4.4.2-1) and modulates the pneumatic cylinder pressure to gradually apply pressure to the tread brakes. The pneumatic tread brake is actuated by an electronically controlled pneumatic (ECP) brake system. The ECP brake system allows the operator to apply a graduated increase or decrease of pneumatic pressure to the braking systems. This provides a graduated braking to the locomotive and transporter. The graduated braking is controlled by a microprocessor based control system that monitors brake cylinder pressure, reservoir tank, and pipe pressure.

Table 6.1.1-4 lists the applicable codes and standards for the pneumatic tread brake subsystems.

Table 6.1.1-4: Pneumatic Tread Brake Subsystem Applicable Codes and Standards

Applicable Code or Standard	Sections	Title
AAR 2004, Section M, S-5529	Entire	*Multiple Unit Pneumatic Brake Equipment for Locomotives*
AAR 2004, Section M, RP-509	Entire	*Braking Ratios*
AAR 2004, Section M, RP-518	Entire	*Brake Shoe Unflanged*
AAR 2004, Section M, RP-599	Entire	*Brake Shoes - High Friction Composition Type for Locomotives*
AAR 2004, Section M, RP-5209	Entire	*Basic Brake Design Data for Freight Locomotives*
AAR 2004, Section M, RP-5596	Entire	*Brake Shoes – Metal Type*

6.1.1.2.2 Disc Brake Subsystem (Alternative 2)

The disc brake subsystem gets braking commands from the LBCS. Currently there are no codes and standards identified for disc braking systems. Disc brakes are typically used in passenger transit not in freight applications. This will be addressed later in the gap analysis.

Table 6.1.1-5 lists the applicable codes and standards for the disc brake subsystems.

Table 6.1.1-5: Disc Brake Subsystem Applicable Codes and Standards

Applicable Code or Standard	Sections	Title
None	N/A	*N/A*

6.1.1.3 Transport Locomotive Coupler

Section 4.1.5.3 of the AAR, states that the vertical loads on the coupler must follow Paragraph 4.1.5 of AAR 2004, Section C - Part II Standard M-1001. Also Section 4.1.7.1 discusses that "the coupling system must be designed such that overriding will not occur and that the train will remain coupled together" (AAR S-2043).

The coupler between the locomotive and the transporter has a sensor that verifies that the coupler is engaged or disengaged. The sensor when disengaged commands the transporter brake system to actuate (i.e. the transporter cannot be moved when disengaged from the locomotive). The sensor is installed per the functional requirements of ANSI/ISA 67.01.01-2002.

The couplers maintain the connection between the transport locomotive and the WP transporter (See Figure 4.3.1-1 and Figure 4.4.1-1). For this requirement, the coupler sensor connection is ITS. The Coupler applicable codes and standards are shown in Table 6.1.1-6.

Table 6.1.1-6: Transport Locomotive Coupler Applicable Codes and Standards

Applicable Code or Standard	Sections	Title
AAR 2004, Section C - Part II, M-1001	4.1.5	*Specification for Design, Fabrication and Construction of Freight Cars*
AAR S-2043	4.1.5.3 4.1.7.1	*Performance Specification for Trains Used to Carry High Level Radioactive Material*
ANSI/ISA 67.01.01-2002*	Entire	*Transducer and Transmitter Installation for Nuclear Safety Applications*

* This nuclear standard applies for nuclear power industry and may not necessarily apply to rail SSCs.

6.2 WP TRANSPORTER

6.2.1 WP Transporter Control System (TCS)

The TCS interfaces with the WP transporter brake control system (TBCS), bedplate control system (BPCS), shield door control system (SDCS), position control system (PCS), and the facility control system (FCS). Inputs are received from power, communications, sensors, and the radiation detector (see Figure 4.3.1-1 and Figure 4.4.2-1).

The TCS controls all activities onboard the transporter. The TCS interlocks the TBCS with the speed sensor, and locomotive (via communications cable) for excessive speed. Also, TCS interlocks the BPCS and SDCS to prevent closing of the shield doors on the WP. The TCS interlocks the radiation detection sensor, position detector, and PCS to allow the WP to be exposed only in acceptable areas (i.e. surface WP loading docks and emplacement drift docking area). The FCS communicates directly with the TCS at the surface WP loading dock (via the WP loading dock umbilical cable).

The TCS will contain the functional and design requirements established in IEEE Std 603-1998, and IEEE 7-4.3.2-2003 for the instrumentation and control portions of the TCS. The additional IEEE and ANSI/ISA Standards will provide the installation/mounting, independence, Setpoints, single failure criteria, and qualification requirements for the system.

Therefore, the TCS is ITS and Table 6.2.1-1 is a list of applicable codes and standards.

Table 6.2.1-1: WP Transporter Control System Applicable Codes and Standards

Applicable Code or Standard	Sections	Title
ANSI/IEEE Std 344-1987*	Entire	*IEEE Recommended Practice for Seismic Qualification of Class 1E Equipment for Nuclear Power Generating Stations*
ANSI/ISA-67.01.01-2002*	Entire	*Transducer and Transmitter Installation for Nuclear Safety Applications*
ANSI/ISA-67.04.01-2000*	Entire	*Setpoints for Nuclear Safety Related Instrumentation-Formally ANSI/ISA-S67.04-2000*
IEEE Std 7-4.3.2-2003*	Entire	*IEEE Standard Criteria for Digital Computers in Safety Systems of Nuclear Power Generating Stations*
IEEE Std 323-2003*	Entire	*IEEE Standard for Qualifying Class 1E Equipment for Nuclear Power Generating Stations*
IEEE Std 379-2000*	Entire	*IEEE Standard Application of the Single-Failure Criterion to Nuclear Power Generating Station Safety Systems*
IEEE Std 384-1992*	Entire	*Standard Criteria for Independence of Class 1E Equipment and Circuits*
IEEE Std 603-1998*	Entire	*Standard Criteria for Safety Systems in Nuclear Power Generating Stations*

* These nuclear standards apply for nuclear power industry and may not necessarily apply to rail SSCs.

6.2.1.1 WP Transporter Brake Control System

The TBCS contains the microprocessor electronics system that performs the functions of the ECP brake system. The TBCS commands the pneumatic tread brake system and disc brake system (Alternative 2 Only) to stop the transporter. The ECP has the capability to gradually apply brake pressure or in emergency situations, to fully engage the brakes.

The TBCS gets the braking commands from the TCS via the communications cable from the locomotive on board operator (see Figure 4.3.2-1 and Figure 4.4.2-1).

The TBCS will contain the functional and design requirements established in IEEE 603-1998 and IEEE 7-4.3.2-2003 for the instrumentation and control portions of the TBCS. The additional IEEE and ANSI/ISA Standards will provide the installation/mounting, independence, Setpoints, single failure criteria, and qualification requirements for the system.

Therefore, the braking systems are ITS and the applicable codes and standards are listed in Table 6.2.1-2.

Table 6.2.1-2: Braking Control System Applicable Codes and Standards

Applicable Code or Standard	Sections	Title
AAR 2004, Section E – Part II, S-4200	Entire	*Electrically Controlled Pneumatic (ECP) Cable-Based Brake Systems – Performance Requirements*
AAR 2004, Section E – Part II, S-4210	Entire	*ECP Cable-Based Brake System Cable, Connectors, and Junction Boxes – Performance Specification*
AAR 2004, Section E – Part II, S-4220	Entire	*ECP Cable-Based Brake DC Power Supply – Performance Specification*
AAR 2004, Section E – Part II, S-4230	Entire	*Intratrain Communication Specification for Cable-Based Freight Train Control Systems (Either S-4230 or S-4300)*
AAR 2004, Section E – Part II, S-4300	Entire	*Performance Requirement for Electronically Controlled Pneumatic (ECP) Radio-Based Freight Brake Systems (Either S-4200 or S-4300)*
AAR S-2043	4.4	*Performance Specification for Trains Used to Carry High Level Radioactive Material*
ANSI/IEEE Std 344-1987*	Entire	*IEEE Recommended Practice for Seismic Qualification of Class 1E Equipment for Nuclear Power Generating Stations*
ANSI/ISA-67.01.01-2002*	Entire	*Transducer and Transmitter Installation for Nuclear Safety Applications*
ANSI/ISA-67.04.01-2002*	Entire	*Setpoints for Nuclear Safety Related Instrumentation*
IEEE Std 7-4.3.2-2003*	Entire	*IEEE Standard Criteria for Digital Computers in Safety Systems of Nuclear Power Generating Stations*
IEEE Std 323-2003*	Entire	*IEEE Standard for Qualifying Class 1E Equipment for Nuclear Power Generating Stations*
IEEE Std 379-2000*	Entire	*IEEE Standard Application of the Single-Failure Criterion to Nuclear Power Generating Station Safety Systems*
IEEE Std 384-1992*	Entire	*Standard Criteria for Independence of Class 1E Equipment and Circuits*
IEEE Std 603-1998*	Entire	*Standard Criteria for Safety Systems in Nuclear Power Generating Stations*

* These nuclear standards apply for nuclear power industry and may not necessarily apply to rail SSCs.

6.2.1.1.1 Pneumatic Tread Brake Subsystem

The pneumatic tread brake subsystem gets braking commands from the TBCS and modulates the pneumatic cylinder pressure to gradually apply pressure to the tread brakes. The pneumatic tread brake is actuated by an ECP brake system. The ECP brake system allows the operator to apply a graduated increase or decrease of pneumatic pressure to the braking systems. This provides a graduated braking to the locomotive and transporter. The graduated braking is controlled by a microprocessor based control system that monitors brake cylinder pressure, reservoir tank, and pipe pressure.

Stated in Section 4.4 of AAR S-2043, the brake system design must follow S-401 (AAR 2004, Section E) with exception to items specifically addressed within, and the brake analysis submittal must include all of the items listed in AAR 2004, Section C - Part II Standard M-1001, Paragraph 1.2.3.2 (AAR S-2043). The ECP brake system must follow the requirements presented

in AAR 2004, Section E – Part II following standards S-4200 (or S-4300), S-4210, S-4220, and S-4230 (AAR S-2043, Section 4.4.1).

The pneumatic tread brake subsystems are ITS and the applicable codes and standards are listed in Table 6.2.1-3.

Table 6.2.1-3: Pneumatic Tread Brake Subsystem Applicable Codes and Standards

Applicable Code or Standard	Sections	Title
AAR 2004, Section C - Part II, M-1001	1.2.3.2	*Specification for Design, Fabrication and Construction of Freight Cars*
AAR 2004, Section E, S-401	Entire	*Freight Car Brake Design Requirements*
AAR S-2043	4.4	*Performance Specification for Trains Used to Carry High Level Radioactive Material*

6.2.1.1.2 Disc Brake Subsystem (Alternative 2)

The disc brake subsystem gets braking commands from the TBCS. However, currently there are no codes and standards identified for disc braking systems. Disc brakes are typically used in passenger transit not in freight applications. This will be addressed later in the gap analysis.

The disc brake subsystems are ITS and the applicable codes and standards are listed in Table 6.2.1-4.

Table 6.2.1-4: Disc Brake Subsystem Applicable Codes and Standards

Applicable Code or Standard	Sections	Title
AAR S-2043	4.4	*Performance Specification for Trains Used to Carry High Level Radioactive Material*

6.2.1.2 WP Transporter Coupler

The WP transporter coupler contains the coupler sensors that send a signal to the TCS to verify the coupler is engaged. When the coupler sensor senses a disengaged coupler a signal is sent to set the transporter brakes. When the sensor senses an engaged coupler, a signal is sent to allow the transporter brakes to be disengaged.

Section 4.1.5.3 of the AAR S-2043, states that the Vertical Loads on the Coupler must follow Paragraph 4.1.5 of AAR 2004, Section C - Part II Standard M-1001. Also Section 4.1.7.1 discusses that “the coupling system must be designed such that overriding will not occur and that the train will remain coupled together” (AAR S-2043).

The couplers maintain the connection between the transport locomotive and the WP transporter. Therefore, the coupler sensor connection is ITS and the applicable codes and standards are shown in Table 6.2.1-5.

Table 6.2.1-5: WP Transporter Coupler Applicable Codes and Standards

Applicable Code or Standard	Sections	Title
AAR 2004, Section C - Part II, M-1001	4.1.5	*Specification for Design, Fabrication and Construction of Freight Cars*
AAR 2004, Section E, S-401	Entire	*Freight Car Brake Design Requirements*
AAR S-2043	4.1.5.3 4.1.7.1	*Performance Specification for Trains Used to Carry High Level Radioactive Material*
ANSI/ISA 67.01.01-2002*	Entire	*Transducer and Transmitter Installation for Nuclear Safety Applications*

* This nuclear standard applies for nuclear power industry and may not necessarily apply to rail SSCs.

6.2.1.3 Bedplate Control System

The bedplate control system (BPCS) contains the interlock logic that prohibits the inadvertent extending or retraction of the bedplate. When inputs from the logical interlocks are met, the BPCS sends the “extend” or “retract” commands to the bedplate drive system.

The BPCS controls the movement of the bedplate. The BPCS interlocks the drive mechanism, locking mechanism, and position sensor.

The BCS will contain the functional and design requirements established in IEEE 603-1998, and IEEE 7-4.3.2-2003 for the instrumentation and control portions of the BCS. The additional IEEE and ANSI/ISA Standards will provide the installation/mounting, independence, Setpoints, single failure criteria, and qualification requirements for the system.

The BPCS is ITS and Table 6.2.1-6 is a list of applicable codes and standards.

Table 6.2.1-6: Bedplate Control System Applicable Codes and Standards

Applicable Code or Standard	Sections	Title
ANSI/ISA-67.01.01-2002*	Entire	*Transducer and Transmitter Installation for Nuclear Safety Applications*
ANSI/ISA-67.04.01-2002*	Entire	*Setpoints for Nuclear Safety Related Instrumentation*
ANSI/IEEE Std 344-1987*	Entire	*IEEE Recommended Practice for Seismic Qualification of Class 1E Equipment for Nuclear Power Generating Stations*
IEEE Std 7-4.3.2-2003*	Entire	*IEEE Standard Criteria for Digital Computers in Safety Systems of Nuclear Power Generating Stations*
IEEE Std 323-2003*	Entire	*IEEE Standard for Qualifying Class 1E Equipment for Nuclear Power Generating Stations*
IEEE Std 379-2000*	Entire	*IEEE Standard Application of the Single-Failure Criterion to Nuclear Power Generating Station Safety Systems*
IEEE Std 384-1992*	Entire	*Standard Criteria for Independence of Class 1E Equipment and Circuits*
IEEE Std 603-1998*	Entire	*Standard Criteria for Safety Systems in Nuclear Power Generating Stations*

* These nuclear standards apply for nuclear power industry and may not necessarily apply to rail SSCs.

6.2.1.3.1 Bedplate Locking Mechanism

The HLRM Cask in AAR S-2043 provides shielding from radioactive materials; likewise, the shielded compartment provides shielding from the WP. The bedplate, within the shielded compartment, supports the emplacement pallet, which serves as a cradle for the WP. Therefore per Paragraph 4.1.8 of the AAR S-2043, the bedplate locking mechanism "must have the ability to withstand any forces resulting from tie-down loads." Therefore, the bedplate locking mechanism is ITS and Table 6.2.1-7 is a list of applicable codes and standards.

Table 6.2.1-7: Bedplate Locking Mechanism Applicable Codes and Standards

Applicable Code or Standard	Sections	Title
AAR S-2043	Paragraph 4.1.8	*Performance Specification for Trains Used to Carry High Level Radioactive Material*

6.2.1.3.2 Bedplate Position Sensor

The bedplate position sensor inputs the bedplate position to the interlock logic in the BPCS. Position logic will not allow the bedplate to extend if inputs from the shield door sensors, for example, do not confirm that the doors are open. The bedplate position sensor indicates whether the bedplate is fully retracted or fully extended.

The ANSI/ISA Standard will provide the installation/mounting requirements for the system.

The bedplate position sensor is ITS and Table 6.2.1-8 is a list of applicable codes and standards.

Table 6.2.1-8: Bedplate Position Sensor Applicable Codes and Standards

Applicable Code or Standard	Sections	Title
ANSI/ISA-67.01.01-2002*	Entire	*Transducer and Transmitter Installation for Nuclear Safety Applications*

* This nuclear standard applies for nuclear power industry and may not necessarily apply to rail SSCs.

6.2.1.4 Shield Door Control System

The shield door control system (SDCS) contains the interlock logic that prohibits the inadvertent opening or closing of the shield doors. When inputs from the logical interlocks are met, the SDCS sends the open or close commands to the shield door drive system.

The SDCS controls the movement of the shield doors. The SDCS interlocks the drive mechanism, locking mechanism, and position sensor.

The SDCS will contain the functional and design requirements established in IEEE 603-1998, and IEEE 7-4.3.2-2003 for the instrumentation and control portions of the SDCS. The additional IEEE and ANSI/ISA Standards will provide the installation/mounting, independence, Setpoints, single failure criteria, and qualification requirements for the system.

The SDCS is ITS and Table 6.2.1-9 is a list of applicable codes and standards.

Table 6.2.1-9: Shield Door Control System Applicable Codes and Standards

Applicable Code or Standard	Sections	Title
ANSI/ISA-67.01.01-2002*	Entire	*Transducer and Transmitter Installation for Nuclear Safety Applications*
ANSI/ISA-67.04.01-2002*	Entire	*Setpoints for Nuclear Safety Related Instrumentation*
ANSI/IEEE Std 344-1987*	Entire	*IEEE Recommended Practice for Seismic Qualification of Class 1E Equipment for Nuclear Power Generating Stations*
IEEE Std 7-4.3.2-2003*	Entire	*IEEE Standard Criteria for Digital Computers in Safety Systems of Nuclear Power Generating Stations*
IEEE Std 323-2003*	Entire	*IEEE Standard for Qualifying Class 1E Equipment for Nuclear Power Generating Stations*
IEEE Std 379-2000*	Entire	*IEEE Standard Application of the Single-Failure Criterion to Nuclear Power Generating Station Safety Systems*
IEEE Std 384-1992*	Entire	*Standard Criteria for Independence of Class 1E Equipment and Circuits*
IEEE Std 603-1998*	Entire	*Standard Criteria for Safety Systems in Nuclear Power Generating Stations*

* These nuclear standards apply for nuclear power industry and may not necessarily apply to rail SSCs.

6.2.1.4.1 Shield Door Locking Mechanism

The HLRM Cask in S-2043 provided shielding from radioactive materials; likewise, the shielded compartment provides shielding from the WP. Therefore AAR S-2043, Paragraph 4.1.8

indicates, the shield door locking mechanism "must have the ability to withstand any forces resulting from tie-down loads." The shield door locking mechanism is ITS and Table 6.2.1-10 is a list of applicable codes and standards for the shield door locking mechanism.

Table 6.2.1-10: Shield Door Locking Mechanism Applicable Codes and Standards

Applicable Code or Standard	Sections	Title
AAR S-2043	4.1.8	*Performance Specification for Trains Used to Carry High Level Radioactive Material*

6.2.1.4.2 Shield Door Hinges

The HLRM Cask in S-2043 provided shielding from radioactive materials; likewise, the shielded compartment provides shielding from the WP. Therefore AAR S-2043, Paragraph 4.1.8 indicates, the shield door hinges "must have the ability to withstand any forces resulting from tie-down loads." The shield door hinges are ITS and Table 6.2.1-10 is a list of applicable codes and standards for the shield door hinges.

Table 6.2.1-11: Shield Door Hinges Applicable Codes and Standards

Applicable Code or Standard	Sections	Title
AAR S-2043	4.1.8	*Performance Specification for Trains Used to Carry High Level Radioactive Material*
AISC 1997	Entire	*Manual of Steel Construction, Allowable Stress Design*

6.2.1.4.3 Shield Door Position Sensor

The shield door position sensor inputs the door position to the SDCS. The sensor will confirm the position of the shield doors to the SDCS control logic. The shield door position sensor indicates when the doors are full closed.

The ANSI/ISA Standard will provide the installation/mounting requirements for the sensor.

The shield door position sensors are ITS and Table 6.2.1-12 contains a list of applicable codes and standards.

Table 6.2.1-12: Shield Door Position Sensor Applicable Codes and Standards

Applicable Code or Standard	Sections	Title
ANSI/ISA-67.01.01-2002*	Entire	*Transducer and Transmitter Installation for Nuclear Safety Applications*

* This nuclear standard applies for nuclear power industry and may not necessarily apply to rail SSCs.

6.2.1.5 Position Control System

The position control system (PCS) interlocks the shield door control logic such that the shield doors can only be opened in safe locations. Position sensors will be embedded in strategic locations within the surface and subsurface areas such that the interlock logic will only allow the shield doors to open in those locations (e.g. in the surface loading areas, and the emplacement gantry loading dock). The PCS permits the TCS to expose a radiation source in safe areas only.

The PCS will contain the functional and design requirements established in IEEE 603-1998, and IEEE 7-4.3.2-2003 for the instrumentation and control portions of the PCS. The additional IEEE and ANSI/ISA Standards will provide the installation/mounting, independence, Setpoints, single failure criteria, and qualification requirements for the system.

Therefore PCS is ITS and Table 6.2.1-13 is a list of applicable codes and standards.

Table 6.2.1-13: Position Control System Applicable Codes and Standards

Applicable Code or Standard	Sections	Title
ANSI/IEEE Std 344-1987*	Entire	*IEEE Recommended Practice for Seismic Qualification of Class 1E Equipment for Nuclear Power Generating Stations*
ANSI/ISA-67.01.01-2002*	Entire	*Transducer and Transmitter Installation for Nuclear Safety Applications*
ANSI/ISA-67.04.01-2002*	Entire	*Setpoints for Nuclear Safety Related Instrumentation*
IEEE Std 7-4.3.2-2003*	Entire	*IEEE Standard Criteria for Digital Computers in Safety Systems of Nuclear Power Generating Stations*
IEEE Std 323-2003*	Entire	*IEEE Standard for Qualifying Class 1E Equipment for Nuclear Power Generating Stations*
IEEE Std 379-2000*	Entire	*IEEE Standard Application of the Single-Failure Criterion to Nuclear Power Generating Station Safety Systems*
IEEE Std 384-1992*	Entire	*Standard Criteria for Independence of Class 1E Equipment and Circuits*
IEEE Std 603-1998*	Entire	*Standard Criteria for Safety Systems in Nuclear Power Generating Stations*

* These nuclear standards apply for nuclear power industry and may not necessarily apply to rail SSCs.

6.2.1.5.1 Position Sensor

The position sensors will be embedded in a suitable location such that instrumentation on board the transporter can sense the presence of the position sensor. When the position sensor is sensed, the logic will enable the shield door controls. In the absence of a position sensor, the shield doors cannot be opened automatically or remotely.

The IEEE and ANSI/ISA Standards will provide the installation/mounting, independence, Setpoints, single failure criteria, and qualification requirements for the sensor.

The position sensor is ITS and the applicable codes and standards are shown in Table 6.2.1-14.

Table 6.2.1-14: Position Sensor Applicable Codes and Standards

Applicable Code or Standard	Sections	Title
ANSI/IEEE Std 344-1987*	Entire	*IEEE Recommended Practice for Seismic Qualification of Class 1E Equipment for Nuclear Power Generating Stations*
ANSI/ISA-67.01.01-2002*	Entire	*Transducer and Transmitter Installation for Nuclear Safety Applications*
ANSI/ISA-67.04.01-2002*	Entire	*Setpoints for Nuclear Safety Related Instrumentation*
IEEE Std 323-2003*	Entire	*IEEE Standard for Qualifying Class 1E Equipment for Nuclear Power Generating Stations*
IEEE Std 379-2000*	Entire	*IEEE Standard Application of the Single-Failure Criterion to Nuclear Power Generating Station Safety Systems*
IEEE Std 384-1992*	Entire	*Standard Criteria for Independence of Class 1E Equipment and Circuits*
IEEE Std 603-1998*	Entire	*Standard Criteria for Safety Systems in Nuclear Power Generating Stations*

* These nuclear standards apply for nuclear power industry and may not necessarily apply to rail SSCs.

6.2.1.6 Radiation Detection Sensor

The purpose of the radiation detection sensor is to detect the presence of a WP within the shielded compartment. The radiation detection sensor inputs the radiation level inside the shielded compartment to the interlock logic in the TCS. A radiation source detected within the shielded compartment will not allow a manual override to open the shield doors.

The IEEE and ANSI/ISA Standards will provide the installation/mounting, independence, Setpoints, single failure criteria, and qualification requirements for the sensor.The radiation detection sensor is ITS and Table 6.2.1-15 is a list of applicable codes and standards.

Table 6.2.1-15: Radiation Detector Sensor Applicable Codes and Standards

Applicable Code or Standard	Sections	Title
ANSI/IEEE Std 344-1987*	Entire	*IEEE Recommended Practice for Seismic Qualification of Class 1E Equipment for Nuclear Power Generating Stations*
ANSI/ISA-67.01.01-2002*	Entire	*Transducer and Transmitter Installation for Nuclear Safety Applications*
ANSI/ISA-67.04.01-2002*	Entire	*Setpoints for Nuclear Safety Related Instrumentation*
IEEE Std 323-2003*	Entire	*IEEE Standard for Qualifying Class 1E Equipment for Nuclear Power Generating Stations*
IEEE Std 379-2000*	Entire	*IEEE Standard Application of the Single-Failure Criterion to Nuclear Power Generating Station Safety Systems*
IEEE Std 384-1992*	Entire	*Standard Criteria for Independence of Class 1E Equipment and Circuits*
IEEE Std 603-1998*	Entire	*Standard Criteria for Safety Systems in Nuclear Power Generating Stations*

* These nuclear standards apply for nuclear power industry and may not necessarily apply to rail SSCs.

6.2.2 Transporter Shielded Doors and Compartment

The HLRM Cask in S-2043 provided shielding from radioactive materials; likewise, the shielded doors and compartment provides shielding from the WP. Paragraph 4.1.8.2 requires that "...securement points on the car body must have the ability to withstand any forces resulting from the tie-down loads" (AAR S-2043).

The AISC 1997, ANSI/AISC N690-1994 and AWS D1.1/D1.1M:2004 will provide the construction of the shielded compartment. The ANSI/ANS-6.1.1-1977 and ANSI/ANS-6.4-1985 will provide the design of the shielding for the shielded compartment.

Therefore, the transporter shielded doors and compartment structure must remain intact during and after a tipover or rockfall. Also, the shielded doors and compartment must maintain the shielding integrity for the protection of personnel. The transporter shielded doors and compartment are ITS and Table 6.2.2-1, contains the applicable codes and standards.

Table 6.2.2-1: Shielded Doors and Compartment Applicable Codes and Standards

Applicable Code or Standard	Sections	Title
AAR S-2043	Paragraph 4.1.8	*Performance Specification for Trains Used to Carry High Level Radioactive Material*
ANSI/AISC N690-1994*	Entire	*American National Standard Specification for the Design, Fabrication, and Erection of Steel Safety-Related Structures for Nuclear Facilities*
ANSI/ANS-6.1.1-1977*	Sections 3 & 4	*Neutron and Gamma-Ray Flux-to-Dose-Rate Factors*
ANSI/ANS-6.4-1985*	Entire	*Guidelines on the Nuclear Analysis and Design of Concrete Radiation Shielding for Nuclear Power Plants*
AWS D1.1/D1.1M:2004	Entire	*Structural Welding Code - Steel*
AISC 1997	Entire	*Manual of Steel Construction, Allowable Stress Design*

* These nuclear standards apply for nuclear power industry and may not necessarily apply to rail SSCs.

6.2.3 Suspension Design

The suspension system is must be designed to remain stable in curves, turnouts, switches, etc during extreme straight winds (90 mph). This is to reduce the likelihood of a tipover.

In Paragraphs 4.2 and 4.3 of AAR S-2043, discusses the nonstructural static and dynamic analysis requirements for the suspension. However, the AAR S-2043 does not address the suspension response during extreme straight winds (90 mph). Therefore, this will be addressed in the gap analysis.

The suspension design is ITS and Table 6.2.3-1 is a list of applicable codes and standards.

Table 6.2.3-1: Suspension Design Applicable Codes and Standards

Applicable Code or Standard	Sections	Title
AAR S-2043	Paragraph 4.2 – 4.3	*Performance Specification for Trains Used to Carry High Level Radioactive Material*

7. REFERENCES

7.1 DOCUMENTS CITED

BSC 2004. *Waste Package Transporter Preclosure Safety Analysis.* 800-MQC-HET0-00200-000-00A. Las Vegas, Nevada: Bechtel SAIC Company. ACC: ENG.20040623.0002. (DIRS 169554)

BSC (Bechtel SAIC Company) 2005. *Nuclear Safety Design Bases for License Application.* 000-30R-MGR0-00400-000-001. Las Vegas, Nevada: Bechtel SAIC Company. ACC: ENG.20050308.0004. (DIRS 171512)

DOE 2004. *Quality Assurance Requirements and Description.* DOE/RW-0333P, Rev. 16. Washington, D.C.: U.S. Department of Energy, Office of Civilian Radioactive Waste Management. ACC: DOC.20040907.0002. (DIRS 171539)

LP-ENG-014-BSC, Rev. 0, ICN 2. *Engineering Studies.* Washington, D.C.: U.S. Department of Energy, Office of Civilian Radioactive Waste Management. ACC: DOC.20040225.0003. (DIRS 168862)

LP-SI.11Q-BSC, Rev. 0, ICN 1. *Software Management.* Washington, D.C.: U.S. Department of Energy, Office of Civilian Radioactive Waste Management. ACC: DOC.20041005.0008. (DIRS 171923)

7.2 CODES AND STANDARDS

AAR S-2043. 2003. *Performance Specification for Trains Used to Carry High-level Radioactive Material.* Washington, D.C.: Association of American Railroads. (DIRS 166338)

AAR 2004. *Manual of Standards and Recommended Practices.* Washington, D.C.: Association of American Railroads. TIC: 256289. (DIRS 169910)

AISC 1997. *Manual of Steel Construction, Allowable Stress Design.* 9th Edition, 2nd Revision, 2nd Impression. Chicago, Illinois: American Institute of Steel Construction. TIC: 240772. (DIRS 107063)

ANSI/AISC N690-1994. 1994. *American National Standard Specification for the Design, Fabrication, and Erection of Steel Safety-Related Structures for Nuclear Facilities.* Chicago, Illinois: American Institute of Steel Construction. TIC: 252734. (DIRS 158835)

ANSI/ANS-6.1.1-1977. *Neutron and Gamma-Ray Flux-to-Dose-Rate Factors.* La Grange Park, Illinois: American Nuclear Society. TIC: 239401. (DIRS 107016)

ANSI/ANS-6.4-1985. *Guidelines on the Nuclear Analysis and Design of Concrete Radiation Shielding for Nuclear Power Plants.* La Grange Park, Illinois: American Nuclear Society. TIC: 204995. (DIRS 107721)

ANSI/IEEE Std 344-1987 (Reaffirmed 1993). *IEEE Recommended Practice for Seismic Qualification of Class 1E Equipment for Nuclear Power Generating Stations.* New York, New York: American National Standards Institute. TIC: 253538. (DIRS 159619)

ANSI/ISA-67.01.01-2002. 2002. *Transducer and Transmitter Installation for Nuclear Safety Applications*. Research Triangle Park, North Carolina: Instrumentation, Systems, and Automation Society. (DIRS 172965)

ANSI/ISA-67.04.01-2002. *Setpoints for Nuclear Safety Related Instrumentation*. Research Triangle Park, North Carolina: Instrument Society of America. (DIRS 172968)

AWS D1.1/D1.1M:2004. 2004. *Structural Welding Code—Steel.* 19th Edition. Miami, Florida: American Welding Society. TIC: 256262 (DIRS 170489)

IEEE Std 7-4.3.2-2003. *IEEE Standard Criteria for Digital Computers in Safety Systems of Nuclear Power Generating Stations.* New York, New York: Institute of Electrical and Electronics Engineers. TIC: 256291. (DIRS 170777)

IEEE Std 323-2003. 2004. *IEEE Standard for Qualifying Class 1E Equipment for Nuclear Power Generating Stations.* New York, New York: Institute of Electrical and Electronics Engineers. TIC: 255697. (DIRS 166907)

IEEE Std 379-2000. 2001. *IEEE Standard Application of the Single-Failure Criterion to Nuclear Power Generating Station Safety Systems.* New York, New York: Institute of Electrical and Electronics Engineers. TIC: 255427. (DIRS 166688)

IEEE Std 384-1992. 1992. *IEEE Standard Criteria for Independence of Class 1E Equipment and Circuits.* New York, New York: Institute of Electrical and Electronics Engineers. TIC: 237497. (DIRS 103105)

IEEE Std 603-1998. *IEEE Standard Criteria for Safety Systems for Nuclear Power Generating Stations.* New York, New York: The Institute of Electrical and Electronics Engineers. TIC: 242993. (DIRS 125916)

8. REVIEWED MATERIAL

The following lists indicate the, Project, Documents, Drawings, and Calculations/Analysis, the Industry Codes and Standards, the Regulatory Documents, the Federal Regulations and the DOE Documents reviewed in the performance of the study.

8.1 REVIEWED DOCUMENTS

Seven documents were identified as the documents to be used for this study. These documents were identified as documents that had potential ITS standards that could be found. Beginning with the Transport Locomotive / WP Transporter Design Calculation a list of documents with all references pertaining to the locomotive and transporter was generated. From this list of reference documents, another sub list of references was generated. This process was continued until a list of all the documents that could potentially discuss ITS requirements had been generated.

Nuclear Safety Design Bases for License Application - 000-30R-MGR0-00400-000-001.

Waste Package Transporter Preclosure Safety Analysis. 800-MQC-HET0-00200-000-00A

Categorization of Event Sequences for License Application - 000-00C-MGR0-00800-000-00Be

Project Design Criteria – 000-3DR-MGR0-00100-000-003

Project Requirements Document – TER-MGR-MD-00001 Rev 02

Project Functional and Operational Requirements. – TDR-MGR-ME-000003 Rev 02

Emplacement and Retrieval System Description Document. – 800-3YD-HE00-00100-000-003e

8.2 REVIEWED DRAWINGS

The following list is the Project drawings depicting the baseline concept of the Transport Locomotive / WP Transporter:

Emplacement and Retrieval General Arrangement Locomotive - 800-MQ0-HES0-00201-000-00B

Emplacement and Retrieval General Arrangement Waste Package Transporter – 800-MQ0-HET0-00101-000-00B

8.3 REVIEWED CALCULATIONS/ANALYSIS

The following Calculations and Analysis are the Project documents used in the development of the baseline concept of the Transport Locomotive / WP Transporter.

Transport Locomotive Calculation - 800-MQC-HES0- 00100-000-00A

Waste Package Transporter Calculation - 800-MQC-HET0- 00100-000-00B

Waste Package Transporter Shielding Design Calculation - 000-00C-HE00- 00100-000-00A

8.4 REVIEWED SYSTEM DESCRIPTION DOCUMENT

The following is the current revision of the System Description Document pertaining to the Transport Locomotive / WP Transporter.

Emplacement and Retrieval System Description Document - 800-3YD-HE00-00100-003e

8.5 REVIEWED INDUSTRY CODES AND STANDARDS

The following represents the codes, standards, regulations, and directives studied for applicability to the recognized ITS SSCs.

AAR S-2043 - *Performance Specification for Trains Used to Carry High-level Radioactive Material*

AAR 1997 - *Manual of Standards and Recommended Practices, Section C – Part II, Specifications for Design, Fabrication and Construction of Freight Cars M-1001, Volume I*

AAR 1997 - *Manual of Standards and Recommended Practices, Section C – Part II, Specifications for Design, Fabrication and Construction of Freight Cars M-1001, Volume II*

AAR 1997 - *Manual of Standards and Recommended Practices, Section D – Truck and Truck Details*

AAR 1998 - *Manual of Standards and Recommended Practices, Section G – Wheels and Axles*

AAR 2001 - *Manual of Standards and Recommended Practices, Section C – Part II, Appendices to Section C-II, Vol. I.*

AAR 2001 - *Manual of Standards and Recommended Practices, Section D – Part II, Code for Side Frame and Truck Bolster Design*

AAR 2002 - *Manual of Standards and Recommended Practices, Section E, Part II – Electronically Controlled Brake Systems*

AAR 2002 - *Manual of Standards and Recommended Practices: Section K, Part II – Railway Communications*

AAR 2002 - *Manual of Standards and Recommended Practices, Section M – Locomotives and Locomotive Equipment*

AAR 2003 - *Manual of Standards and Recommended Practices, Section B – Couplers & Freight Car Draft Components*

AAR 2003 - *Manual of Standards and Recommended Practices: Section E-Brakes and Brake Equipment*

AAR 2003 - *Manual of Standards and Recommended Practices: Section K, Part I – Railway Electronics*

AISC 1997 - *Seismic Provisions for Structural Steel Buildings*

AISC 1997 - *Manual of Steel Construction, Allowable Stress Design*

ANSI/AISC N690-1994 - *American National Standard Specification for the Design, Fabrication, and Erection of Steel Safety-Related Structures for Nuclear Facilities*

ANSI/ANS-6.1.1-1977 - *Neutron and Gamma-Ray Flux-to-Dose-Rate Factors*

ANSI/ANS-6.4-1985 - *Guidelines on the Nuclear Analysis and Design of Concrete Radiation Shielding for Nuclear Power Plants*

ANSI/AWS D14.1-97-1998 - *Welding of industrial & Mill cranes & other Mechanical Handling equipment*

ANSI/ISA-67.01.01-2002 - *Transducer and Transmitter Installation for Nuclear Safety Applications*

ANSI/ISA-67.04.01-2002 - *Setpoints for Nuclear Safety Related Instrumentation*

ANSI-ISA-S84.01 - *Application of Safety Instrumented Systems for Process Industries*

AWS D1.1/D1.1M-2002 - *Structural Welding Code*

AWS D1.6:1999 - *Structural Welding Code – Stainless Steel*

IEEE Std. 7-4.3.2-2003 - *IEEE Standard Criteria for Digital Computers in Safety Systems of Nuclear Power Generating Stations*

IEEE Std 323-2003 - *IEEE Standard for Qualifying Class 1E Equipment for Nuclear Power Generating Stations*

IEEE Std 344-1987 - *IEEE Recommended Practice for Seismic Qualification of Class 1E Equipment for Nuclear Power Generating Stations*

IEEE Std 379-1994 - *IEEE Standard Application of the Single-Failure Criterion to Nuclear Power Generating Station Safety Systems*

IEEE 384-1992 - *Standard Criteria for Independence of Class 1E Equipment and Circuits*

IEEE Std 603-1998 - *IEEE Standard Criteria for Safety Systems for Nuclear Power Generating Stations*

UL 508-December 2, 2003– *Industrial Control Equipment*

UL 583-July 12, 1999– *Electric Battery Powered Industrial Trucks*

UL 698-March 15, 1999 – *Industrial Control Equipment for Use in Hazardous (Classified) Locations*

8.6 REVIEWED REGULATORY DOCUMENTS

NUREG-0700 (O'Hara et al. 2002), - Human-System Interface Design Review Guidelines

Regulatory Guide 8.8 - *Information Relevant to Ensuring that Occupational Radiation Exposures at Nuclear Power Stations Will be as Low as is Reasonably Achievable*

8.7 REVIEWED FEDERAL REGULATIONS

10 CFR Part 20, - *Standard for Protection Against Radiation.*

10 CFR Part 71, - *Packaging and Transportation of Radioactive Material*

29 CFR Part 1910, - *Occupational Safety and Health*

49 CFR Part 172, - *Hazardous Material Table*

49 CFR Part 173 – *Shippers*

49 CFR Part 220 – *Railroad Communications*

49 CFR Part 229 & 238 - *Locomotive Crashworthiness; Proposed Rule*

49 CFR Parts 229, 231, and 232 - *Brake System Safety Standards for Freight and Other Non-Passenger Trains and Equipment; End-of-Train Devices; Final Rule*

8.8 REVIEWED DOE DOCUMENTS

DOE-STD-1090-2001, - *Hoisting and Rigging*

DOE-HDBK-1140-2001 – *Human Factors/Ergonomics Handbook*